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(54) Coating cellulose fibre substrates using powder coatings

(57) A cellulose fibre substrate such as a wood based material is coated by depositing an electrostatically charged or uncharged coating powder on it to form a coating and then using radiant heat to cure the coating powder. The coating powder typically contains a resin with a curing agent and may also include one or more flow agents, pigments, non-pigmenting mineral fillers and waxes, etc. The radiant heat is preferably applied in the form of infrared radiation typically having a wavelength in the region of from 1 to 5 microns.

SPECIFICATION

Coating cellulose fibre substrates using powder coatings

This invention relates to the use of powder coatings for coating substrates made from cellulose fibre materials such as, for example, timber articles, wooden boards, chipboard, hardboard, cardboard and paper.

The high cost of solvents for conventional liquid coatings has made the use of powder coatings more attractive. However, although powder coatings have been used for some time for coating metal articles using electrostatically charged powder the attraction to the metal depends on its electrical conductivity and it has been thought impossible to use the same techniques for wood based substrates because they are substantially non-conducting. Another difficulty with the application of powder coatings on wood is that of applying heat to melt and cure the powder. For metal articles, this heat is usually supplied by gas, oil or electrically heated convection ovens, but this heat can affect a wood based substrate by causing moisture, sap or resin to be exuded causing defects in the coating. Also changes in the physical dimensions of the substrate can occur due to drying.

It is an object of the present invention to provide a process for using powder coatings for coating a cellulose fibre substrate.

According to the present invention there is provided a method of coating a cellulose fibre substrate including the steps of depositing an electrostatically charged or an uncharged coating powder on the substrate to form a coating thereon and subsequently using radiant heat to cure the coating powder adhering to the substrate.

Although the cellulose fibure substrates have low electrical conductivity, it has been found that the conductivity is sufficient for a coating of powder to adhere to the surface provided that either the substrate is of sufficient thickness to have adequate electrical conductivity for a single earthing point to be sufficient or the substrate is backed by an earthed conductive sheet or has a plurality of earthing points distributed over it. A coating of powder can also be produced by allowing the powder to fall on to the substrate without using electrostatic attraction; this is particularly suitable for coating one surface of a substantially flat sheet, so that the powder is held on the substrate by gravity.

The radiant heat is preferably in the form of infra-red radiation from suitable lamps and it has been found that wavelengths in the region from 1.0 to 1.5 microns provide the best curing of the powder coating without overheating the substrate, although infra-red radiation having a wavelength in the region 1.5 to 5 microns can be used and produces good results. Intensities of the shorter wavelength infra-red radiation found suitable are about 2 to 10 watts per centimetre of lamp length and 1 to 4 watts per centimetre of lamp length for the longer wavelength radiation. A suitable distance of the lamps from the substrate is from 2 to 20 cms, a shorter distance than this having been found to cause scorching of the powder and a greater distance having been found to cause the substrate to overheat before the powder is fully cured.

The coating powder will typically contain a suitable resin with a curing agent and may also include, for example, one or more flow agents, pigments non-pigmenting mineral fillers and waxes. Other ingredients in the powder which may be added beneficially for specific purposes include, for example, solid plasticizers, ultra-violet absorbing agents, catalysts and anti-cratering agents.

The term "cellulose fibre substrate" includes, for example, wood, chipboard, fibre board, hardboard, cardboard, plywood, veneer, block board and paper including articles made from regenerated cellulose. The invention is especially suitable for coating a substrate of any wood based material. Such material has a small electrical conductivity due to its water content which is is believed enables the substrate to provide, if required, adequate electrostatic attraction for the powder. If the substrate is relatively thick then the electrical capacitance of the substrate has been found to be adequate to hold the electrostatically charged coating powder whilst it is cured by radiant heat, using a single earthing point on the substrate. If, however, the substrate is thin then it is preferable to provide an electrically conductive backing which is connected to earth or at least a plurality of distributed earth points so that the electrostatic charge induced into the substrate by the coating powder can be discharged to earth.

The powder may be applied by an electrostatic spray gun to the substrate using conventional powder spraying equipment such as that known by the names Volstatic, Gema and Controsion. Alternatively the powder may be placed in a vibratory hopper under which the substrate to be coated is passed, the hopper being maintained at a suitable electrical potential to provide the required electrostatic charge to the particles sufficient to give a thin even film of powder on the surface of the substrate. Alternatively the powder may be placed in a vibratory hopper under which the substrate to be coated is passed, using gravity rather than electrostatic charging to apply an even film of powder. The substrate whilst being coated with powder using an electrically charged spray may be hung vertically from a fixed point or a conveyor to provide an

earthing point for the substrate. Several earthing points would be provided for large areas or thinner sheets so as to provide adequate electrical conductivity from the surface being coated to earth. Alternatively the substrates may be coated in a horizontal position using a flat conveyor passing the sheets under fixed or reciprocating electrostatic spray guns. The conveyor may have an electrically conductive support for the substrate so as to provide a good earth connection over the back face of the material.

After the powder coating is formed on the substrate it is cured by subjecting the powder film to radiant heat, preferably in the form of infra-red radiation. It has been found that the wavelength, intensity and separation of the lamps from the substrate need to be selected carefully to ensure a good flow of the coating during curing and to complete the cure of the coating without overheating the substrate. Infra-red lamps producing radiation in the wavelength range from 1.00 to 1.5 microns may be provided spaced from 2 to 20 cms from the substrate so as to provide a power intensity of from 2 to 10 watts per centimetre of lamp length and preferably about 4.3 watts per centimetre. Alternatively the lamps may produce radiation of wavelength in the range 1.5 to 5 microns and spaced the same distance from the substrate as for the shorter radiation to produce a power intensity of from 1 to 5 watts per centimetre of lamp length and preferably about 2 watts per centimetre

It has been found that using the coating compositions described below a period of between 45 seconds and 2 minutes is required for a white powder coating and from 30 seconds to 1½ minutes for a black powder coating to effect curing of the coating.

Although most commercially available powder coatings can be applied electrostatically to cellulose fibre substrates and can be caused to flow and cure under infra-red radiation as described above it has been found that improved coatings can be obtained using coating compositions specifically intended for the purpose. For example, the following coating compositions have been found to give good results.

FOR A WHITE COATING

Quantity		*Ingredient*	*Example*
500	parts	Resin	Polyester
20–80	parts	Curing agent	Triglycidyl isocyanurate
1–10	parts	Flow agent	Polyacrylate
50–400	parts	Pigment	Titanium dioxide
0–300	parts	Extender	Calcium carbonate
0–50	parts	Wax	Polyethylene

FOR A BLACK COATING

Quantity		*Ingredient*	*Example*
500	parts	Resin	Epoxy
10–50	parts	Curing agent	Amine
1–10	parts	Flow agent	Polyacrylate
0–3	parts	Pigment	Carbon black
0–300	parts	Extender	Calcium carbonate
0–50	parts	Wax	Polyethylene

When the above coating compositions were electrostatically sprayed on to eucalpytus based hardboard, they were cured using infra-red radiation having a wavelength in the 1.0 to 1.5 micron range of intensity 4.3 watts per centimetre in 1½ minutes and 1 minute respectively.

The resin used should preferably have a softening temperature between 70°C and 120°C, a Tg of between 40°C and 80°C, a melt index between 2 gm/min and 30 gm/min (ASTI D1238–62T) and a density of 1.1 to 1.4 gm/ml at 23°C. If the resin is a polyester it may incorporate esters of terephthalic and similar polyacids and polyols such as glycols with from 2 to 10 carbon atoms. The preferable curing agent shall be mainly functional through glycidyl groups, and may be a trifunctional material such as Triglycidyl Isocyanurate (TGIC) Tri(epoxy propyl) Isocyanurate (TEPIC), or an epoxy resin of epoxide equivalent between 400 and 1,000 or an isocyanate.

Alternative coating powders may be based on other resins, e.g. epoxy resins such as those cured with substituted or unsubstituted dicyandiamides, amines, amidines or anhydrides; the curing systems may in some cases contain an accelerator.

Pigments which may be included are iron oxides, titanium oxide organics such as phthalocyanines, azo- and dioxazine dyestuffs, carbon black, lithopone, zinc oxide, and pigments based on cadmium, lead or chromium.

The compositions may also include absorbing agents for ultra-violet light, plasticizers and catalysts to suit specific purposes for which the coating may be required.

Additional or alternative non-pigmenting extenders which may be included are barium sulphate, magnesium carbonate, calcium carbonate, silica, talc silicates or other mineral fillers.

Additional or alternative flow agents which may be included are fluorocarbons, silicons or other commercially used anti-cratering agents.

Additional or alternative waxes which may be included are polypropylene, stearamide, gums or high molecular weight polymeric materials.

CLAIMS

1. A method of coating a cellulose fibre substrate including the steps of depositing an electrostatically charged or an uncharged coating powder on the substrate to form a coating thereon and subsequently using radiant heat to cure the coating powder adhering to the substrate.

2. A method according to claim 1 wherein the substrate is electrically connected to earth during deposition of the coating powder, the powder being electrostatically charged and caused to impinge on the substrate.

3. A method according to claim 2 wherein the powder is projected towards the substrate by means of an electrostatically charging spray gun.

4. A method according to claim 2 wherein the powder is arranged to fall on to the substrate from a vibratory hopper which is maintained at a suitable electrical potential.

5. A method according to claim 2, 3 or 4 wherein the substrate is thin and is backed by an earthed electrically conducting surface during deposition of the coating powder thereon.

6. A method according to claim 2, 3 or 4 including making a plurality of earth connections to the substrate prior to depositing the coating powder thereon.

7. A method according to claim 1 wherein the powder is arranged to fall on to the substrate from an earthed vibratory hopper so that the powder is uncharged.

8. A method according to any preceding claim wherein the radiant heat is infra-red radiation.

9. A method according to claim 8 wherein the infra-red radiation has a wavelength in the range 1.0 to 1.5 microns.

10. A method according to claim 8 wherein the wavelength of the radiation lies in the range 1.5 to 5 microns.

11. A method according to claim 9 wherein the intensity of the radiation incident on the powder is between 2 to 10 watts per centimetre of length of the radiation source.

12. A method according to claim 11 wherein the intensity is 4.3 watts per centimetre of length of the radiation source.

13. A method according to claim 10 wherein the intensity of the infra-red radiation on the powder coating is in the range 1 to 5 watts per centimetre of length of the radiation source.

14. A method according to claim 13 wherein the intensity is 2 watts per centimetre of length of the radiation source.

15. A method according to any of claims 8 to 14 wherein the infra-red radiation is provided by lamps spaced between 2 and 20 cms from the powder coating

16. A method according to any preceding claim wherein the powder coating includes a resin, a curing agent and a flow agent.

17. A method according to claim 16 wherein the resin is a polyester resin and the curing agent is triglycidyl isocyanurate.

18. A method according to claim 16 wherein the resin is a polyester resin and the curing agent is an isocyanate.

19. A method according to claim 16 wherein the resin is an epoxy resin and the curing agent is substituted dicyandiamide, an amine, an amidine, an anhydride or a polyester with or without an accelerator.

20. A method according to any of claims 16 to 19 wherein the powder also includes a pigment.

21. A method according to any of claims 16 to 20 wherein the powder also includes a non-pigmenting filler.

22. A method according to claim 16 to 21 wherein the powder also includes a high molecular weight wax.

23. A method according to claim 16 to 22 wherein the powder also includes an ultra-violet light absorbing agent

24. A method according to claim 16 to 23 wherein the powder also includes a plasticizer.

25. A method according to claim 16 to 24 wherein the powder also includes a catalyst.

26. A method according to claim 16 to 25 wherein the powder also includes an anti-cratering agent.

27. A method according to any of claims 1 to 15 wherein the coating powder has a composition substantially as described in either of the examples of coating compositions described herein or modified as herein described.

28. A method of coating a cellulose fibre substrate according to claim 1 substantially as herein described.

29. A coated cellulose fibre substrate produced by a method according to any preceding

claim.

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